



Portland Water Bureau Micro Hydro Case Study

David Peters, PE
Bryan Robinson, PE
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Outline

- Project Background
- Site Selection and Evaluation
- Design Process Requirements
- Installation
- Lessons Learned and future considerations



Portland Water Bureau System



- Bull Run Elevation at Headworks 750 feet
- Approximately 257 active pressure regulators throughout distribution network

PWB Turbine History



- 1894 Installed (2) Pelton wheel turbines

Pre Project Site Selection

- Power Available
- Existing Vault
- Power use at site
- Feasibility
- O&M/Safety
- Water Quality
- Capital Cost
- Environmental Impacts
- Social Impacts
- Revenue Generation



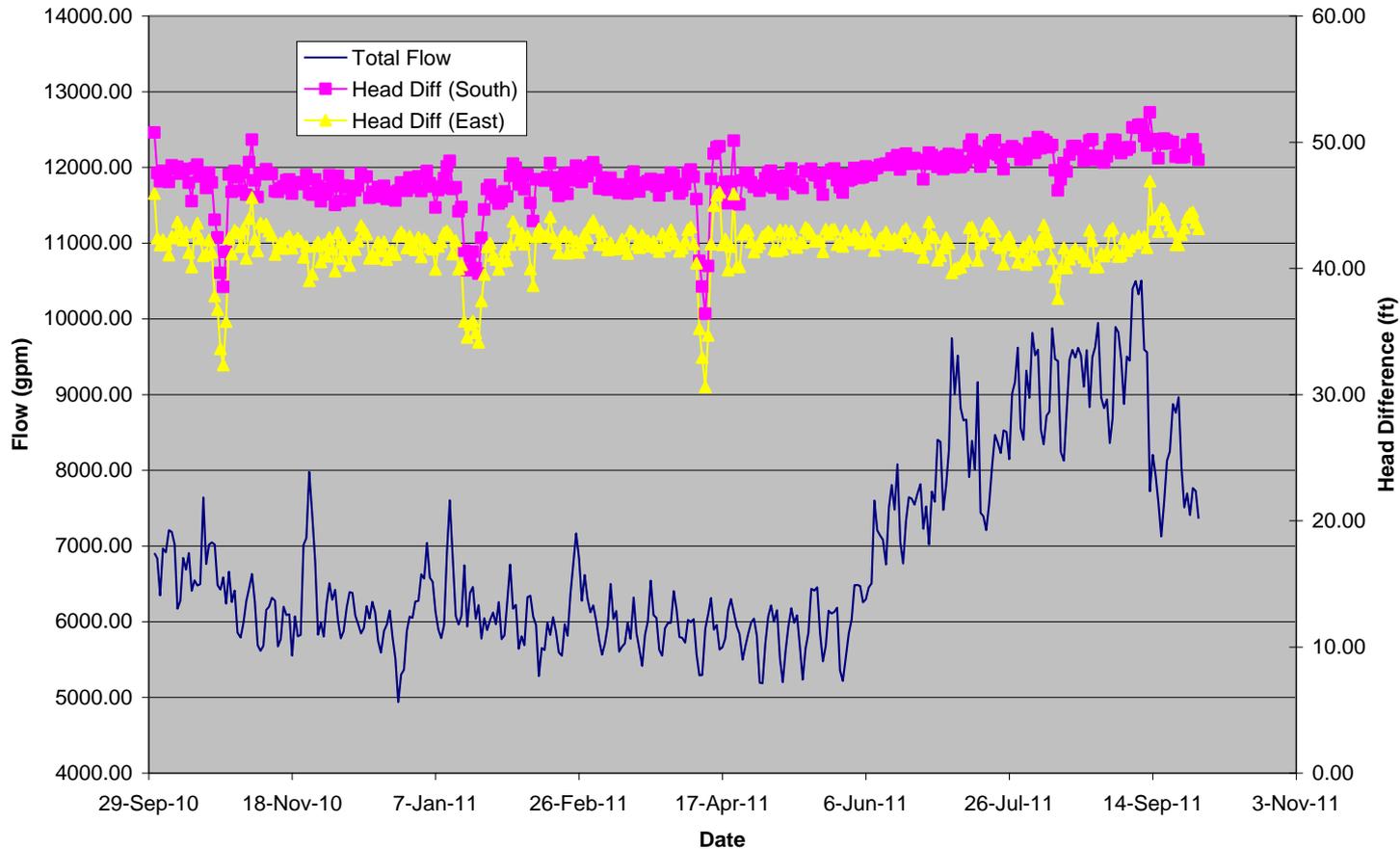
Vernon Site Characteristics

- 3 existing vaults
- Off street location
- 3-phase power available at the site
- High flow rate and head pressure



Vernon Site Characteristics

Vernon Flow vs. Head



Pre-Design

- Oregon Water Rights
 - 6 month wait
 - Send letter to approximately 30 agencies inviting comments
 - Public meeting at the site
- Apply for Conduit Exemption with Federal Energy Regulatory Committee
 - Wait
 - And wait
 - Proceed with design



Agreements

- Facility Study
- Power Purchase
- Infrastructure Connection
- Energy Trust
- American Recovery and Reinvestment Act (ARRA)
- Neighborhood Association
- State of Oregon - BETC



Design Requirements

- Replace 16" regulator with turbine in existing vault
- Restore 6" regulator in vault
- Maintain working clearances to meet electrical and safety codes



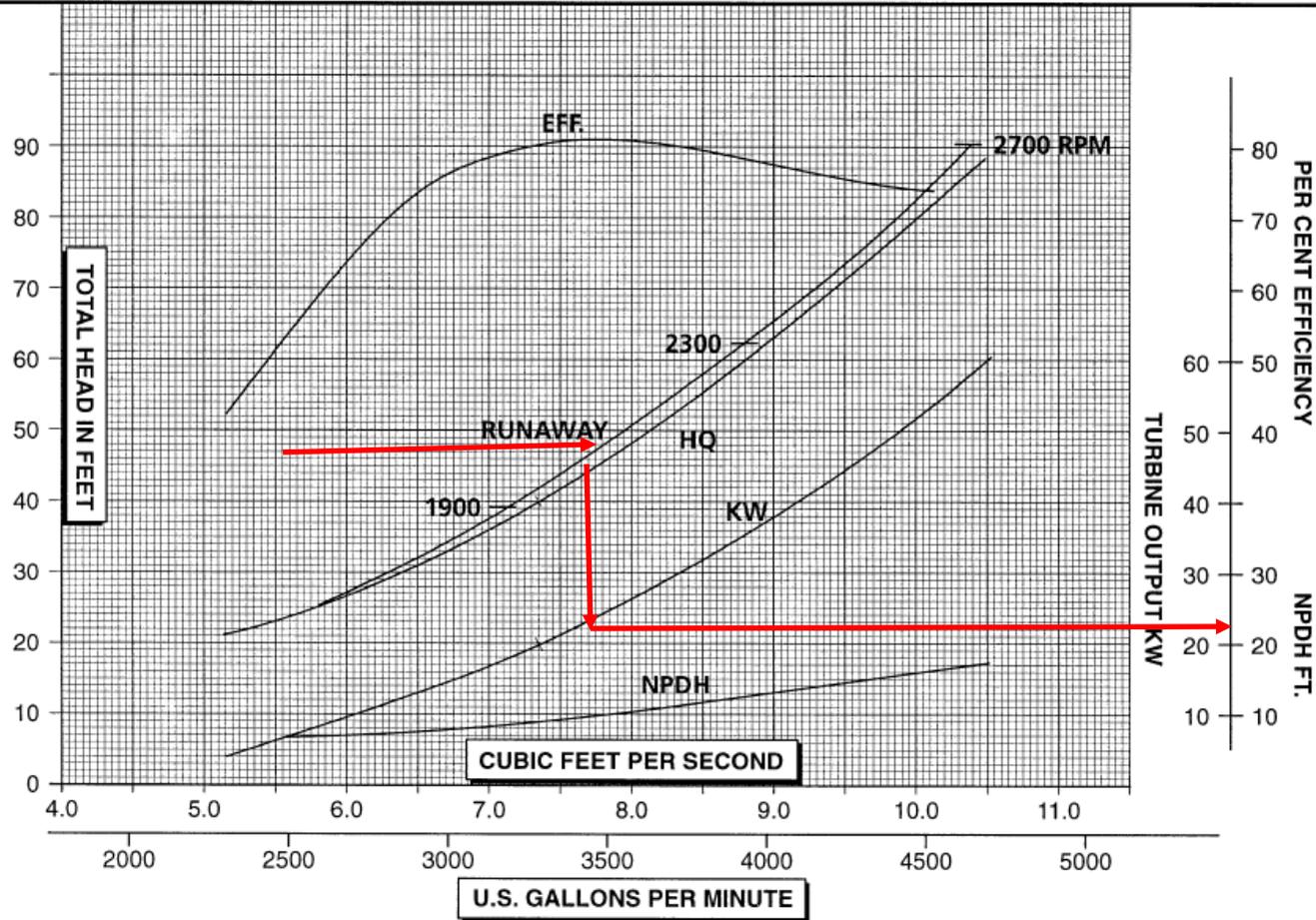
Design Requirements

- Safety Improvements
 - Improved Access
 - Lights in Vault
 - Ventilation Fan
 - Intruder Alarms



Turbine Selection

INLET = 10.0 IN. EXHAUST = 10.0 IN.	$N_S = 4100$	SPEED = 1225 RPM	TURBINE MODEL – 10 TR1
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10 TR1	CORNELL PUMP COMPANY • PORTLAND, OREGON	CORNELL
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Pre-Construction

- Equipment Purchase Contract
- FERC final review and site evaluation with 3 month wait
- Utilize City Electrical Contract
- PWB M&C crews used for Installation



Construction

- Rebuild Structural integrity of Vault



Construction

- New piping and electrical pad prior to vault lid



Construction



Construction

- New Vault top and Ladders



Final Mechanical Layout

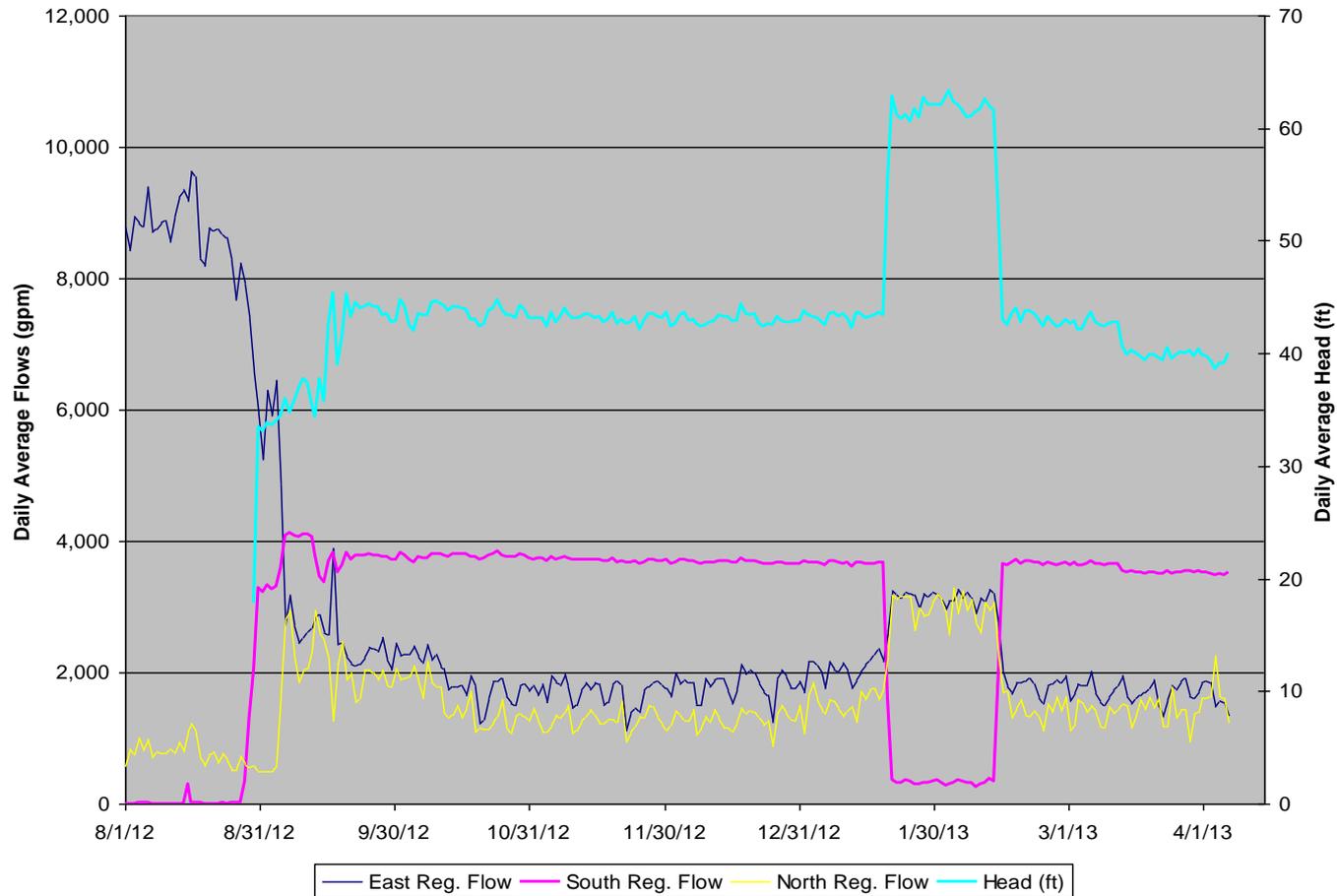


Final Electrical



Hydro Performance

Vernon Micro Hydro



Production Summary

Actual Production

Month	Avg Flow (gpm)	Avg Head Difference (ft)	Days	On peak Energy Generated (kWh)	Off Peak Energy Generated (kWh)	Total Power Production (kWh)
Sep-12	3739	39.43	30	5854	4867	10721
Oct-12	3775	44.01	31	7603	5379	12982
Nov-12	3715	43.20	30	7403	5001	12404
Dec-12	3683	43.06	31	7387	5432	12819
Jan-13	2419	50.25	31	4570	3548	8118
Feb-13	2300	52.0	28	3616	2370	5986
Mar-13	3500	39.5	31	6588	5068	11656
Apr-13	0	0.0				12000
May-13	0	0.0				12000
Jun-13	0	0.0				12000
Jul-13	0	0.0				12000
Aug-13	0	0.0				12000

Avg Annual Power Production

135000

* System came online September 8th

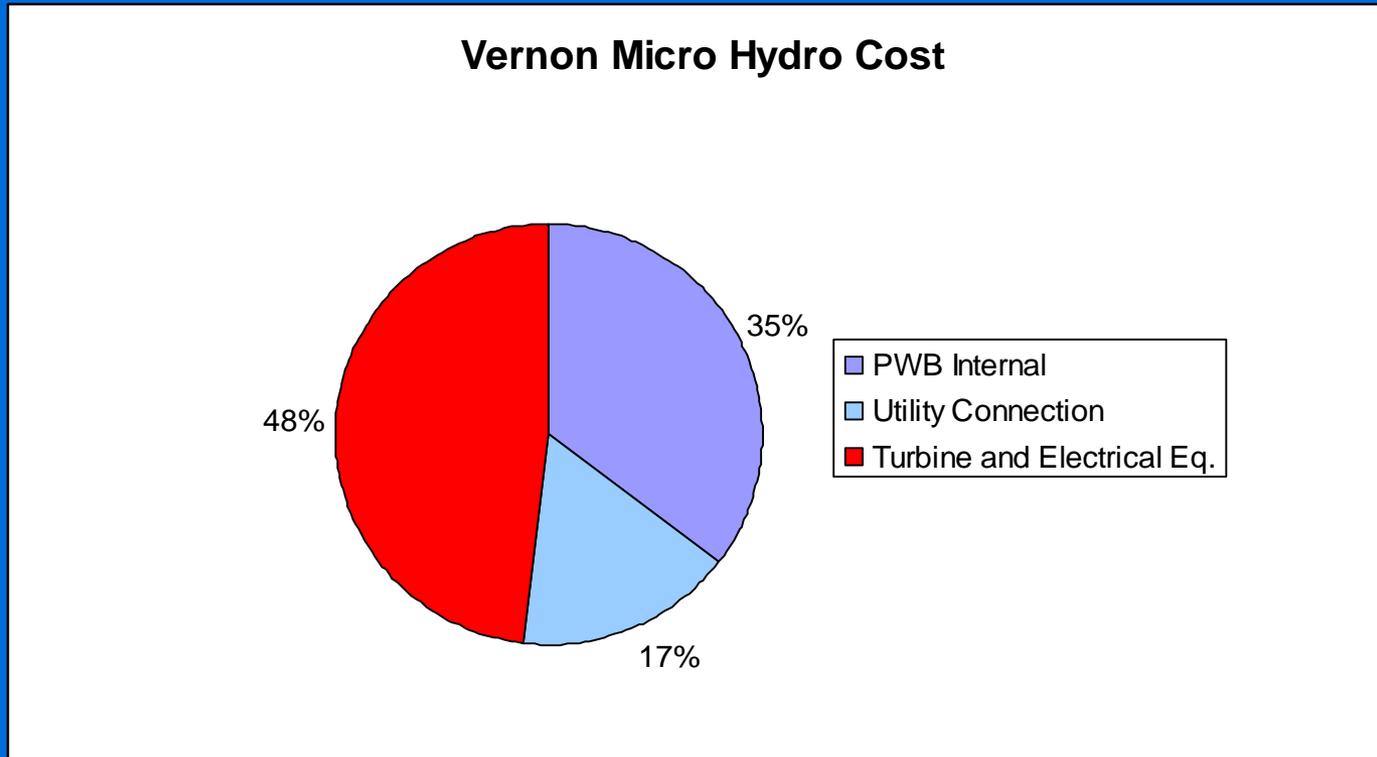
** Broken Solenoid system went down on January 20th

Financial Incentives

- EnergyTrust of Oregon - \$65,000
- Business Energy Tax Credit - \$38,000
- American Recovery and Reinvestment Act of 2009 - \$65,000

- Total Cost to PWB after incentives
\$375,000

Cost Summary



- Cost increase of approximately \$120,000 due to no 3-phase power on site

Lessons Learned Future Design Considerations

- Understand FERC process
- Utility infrastructure in place?
- Utility willingness to participate?
- Can energy be used on site?
- What is the constructability of the site?



Acknowledgements

- EnergyTrust of Oregon
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 - Ryan Nelson – Structural Engineer

Questions

